INTERNATIONAL STANDARD

ISO 10140-2

First edition
2010-09-01

Acoustics — Laboratory measurement of sound insulation of building elements —

Part 2: Measurement of airborne sound insulation

Acoustique — Mesurage en laboratoire de l'isolation acoustique des éléments de construction —

Partie 2: Mesurage de l'isolation au bruit aérien

Reference number
ISO 10140-2:2010(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10140-2 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

This first edition of ISO 10140-2, together with ISO 10140-1, ISO 10140-3, ISO 10140-4 and ISO 10140-5, cancels and replaces ISO 140-1:1997, ISO 140-3:1995, ISO 140-6:1998, ISO 140-8:1997, ISO 140-10:1991, ISO 140-11:2005 and ISO 140-16:2006, which have been technically revised.

It also incorporates the Amendments ISO 140-1:1997/Amd.1:2004 and ISO 140-3:1995/Amd.1:2004.

ISO 10140 consists of the following parts, under the general title Acoustics — Laboratory measurement of sound insulation of building elements:

— *Part 1: Application rules for specific products*

— *Part 2: Measurement of airborne sound insulation*

— *Part 3: Measurement of impact sound insulation*

— *Part 4: Measurement procedures and requirements*

— *Part 5: Requirements for test facilities and equipment*

Introduction

ISO 10140 (all parts) concerns laboratory measurement of the sound insulation of building elements (see Table 1).

ISO 10140-1 specifies the application rules for specific elements and products, including specific requirements for preparation, mounting, operating and test conditions. This part of ISO 10140 and ISO 10140-3 contain the general procedures for airborne and impact sound insulation measurements, respectively, and refer to ISO 10140-4 and ISO 10140-5 where appropriate. For elements and products without a specific application rule described in ISO 10140-1, it is possible to apply this part of ISO 10140 and ISO 10140-3. ISO 10140-4 contains basic measurement techniques and processes. ISO 10140-5 contains requirements for test facilities and equipment. For the structure of ISO 10140 (all parts), see Table 1.

ISO 10140 (all parts) was created to improve the layout for laboratory measurements, ensure consistency and simplify future changes and additions regarding mounting conditions of test elements in laboratory and field measurements. It is intended for ISO 10140 (all parts) to present a well-written and arranged format for laboratory measurements.

It is intended to update ISO 10140-1 with application rules for other products. It is also intended to incorporate ISO 140-18 into ISO 10140 (all parts).

Table 1 — Structure and contents of ISO 10140 (all parts)

Relevant part of ISO 10140	Main purpose, contents and use	Detailed content
ISO 10140-1	It indicates the appropriate test procedure for elements and products. For certain types of element/product, it can contain additional and more specific instructions about quantities and test element size and about preparation, mounting and operating conditions. Where no specific details are included, the general guidelines are according to ISO 10140-2 and ISO 10140-3.	Appropriate references to ISO 10140-2 and ISO 10140-3 and product-related, specific and additional instructions on: — specific quantities measured; — size of test element; — boundary and mounting conditions; — conditioning, testing and operating conditions; — additional specifics for test report.
ISO 10140-2	It gives a complete procedure for airborne sound insulation measurements according to ISO 10140-4 and ISO 10140-5. For products without specific application rules, it is sufficiently complete and general for the execution of measurements. However, for products with specific application rules, measurements are carried out according to ISO 10140-1, if available.	— Definitions of main quantities measured — General mounting and boundary conditions — General measurement procedure — Data processing — Test report (general points)
ISO 10140-3	It gives a complete procedure for impact sound insulation measurements according to ISO 10140-4 and ISO 10140-5. For products without specific application rules, it is sufficiently complete and general for the execution of measurements. However, for products with specific application rules, measurements are carried out according to ISO 10140-1, if available.	— Definitions of main quantities measured — General mounting and boundary conditions — General measurement procedure — Data processing — Test report (general points)
ISO 10140-4	It gives all the basic measurement techniques and processes for measurement according to ISO 10140-2 and ISO 10140-3 or facility qualifications according to ISO 10140-5. Much of the content is implemented in software.	— Definitions — Frequency range — Microphone positions — SPL measurements — Averaging, space and time — Correction for background noise — Reverberation time measurements — Loss factor measurements — Low-frequency measurements — Radiated sound power by velocity measurement
ISO 10140-5	It specifies all information needed to design, construct and qualify the laboratory facility, its additional accessories and measurement equipment (hardware).	Test facilities, design criteria: — volumes, dimensions; — flanking transmission; — laboratory loss factor; — maximum achievable sound reduction index; — reverberation time; — influence of lack of diffusivity in the laboratory. Test openings: — standard openings for walls and floors; — other openings (windows, doors, small technical elements); — filler walls in general. Requirements for equipment: — loudspeakers, number, positions; — tapping machine and other impact sources; — measurement equipment. Reference constructions: — basic elements for airborne and impact insulation improvement; — corresponding reference performance curves.

Acoustics — Laboratory measurement of sound insulation of building elements —

Part 2:
Measurement of airborne sound insulation

1 Scope

This part of ISO 10140 specifies a laboratory method for measuring the airborne sound insulation of building products, such as walls, floors, doors, windows, shutters, façade elements, façades, glazing, small technical elements, for instance transfer air devices, airing panels (ventilation panels), outdoor air intakes, electrical raceways, transit sealing systems and combinations, for example walls or floors with linings, suspended ceilings or floating floors.

The test results can be used to compare the sound insulation properties of building elements, classify elements according to their sound insulation capabilities, help design building products which require certain acoustic properties and estimate the *in situ* performance in complete buildings.

The measurements are performed in laboratory test facilities in which sound transmission via flanking paths is suppressed. The results of measurements made in accordance with this part of ISO 10140 are not applicable directly to the field situation without accounting for other factors affecting sound insulation, such as flanking transmission, boundary conditions and total loss factor.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 140-2, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 2: Determination, verification and application of precision data*

ISO 717-1, *Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation*

ISO 10140-1, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 1: Application rules for specific products*

ISO 10140-4, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 4: Measurement procedures and requirements*

ISO 10140-5, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 5: Requirements for test facilities and equipment*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
sound reduction index
R
ten times the common logarithm of the ratio of the sound power, W_1, that is incident on the test element to the sound power, W_2, radiated by the test element to the other side

$$R = 10 \lg \frac{W_1}{W_2} \tag{1}$$

NOTE 1 R is expressed in decibels.

For laboratory measurements using sound pressure, the sound reduction index is calculated using:

$$R = L_1 - L_2 + 10 \lg \frac{S}{A} \tag{2}$$

where

L_1 is the energy average sound pressure level in the source room, in decibels;

L_2 is the energy average sound pressure level in the receiving room, in decibels;

S is the area of the free test opening in which the test element is installed, in square metres;

A is the equivalent sound absorption area in the receiving room, in square metres.

NOTE 2 The derivation of Equation (2) from Equation (1) assumes that the sound fields are diffuse and that the only sound radiated into the receiving room is from the test element.

NOTE 3 The expression “sound transmission loss” (TL) is also in use in English-speaking countries. It is equivalent to “sound reduction index”.

NOTE 4 Related quantities can be introduced in other documents or test codes, often by adding subscripts, i.e. R_I for the sound reduction index as measured by intensity methods, R_s as the sound reduction index per unit length of slits or ΔR as the improvement in sound reduction index by linings or suspended ceilings.

3.2
apparent sound reduction index
R'
ten times the common logarithm of the ratio of the sound power, W_1, that is incident on a test element to the total sound power radiated into the receiving room if, in addition to the sound power, W_2, radiated by the test element, the sound power, W_3, radiated by flanking elements or by other components is significant

$$R' = 10 \lg \left(\frac{W_1}{W_2 + W_3} \right) \tag{3}$$

NOTE 1 R' is expressed in decibels.

NOTE 2 In general, the sound power transmitted into the receiving room consists of the sum of several components. Also, in this case, under the assumption that there are diffuse sound fields in the two rooms, the apparent sound reduction index is evaluated from Equation (4).

$$R' = L_1 - L_2 + 10 \lg \frac{S}{A} \tag{4}$$

Thus, in the apparent sound reduction index, the sound power transmitted into the receiving room is related to the sound power that is incident on the test element, as in Equation (2), irrespective of the actual conditions of transmission.

3.3
element-normalized level difference
$D_{n,e}$
level difference corresponding to a reference value of absorption area in the receiving room with sound transmission through the small technical element only; this level difference is evaluated from Equation (5)

$$D_{n,e} = L_1 - L_2 + 10 \lg\left(\frac{A_0}{A}\right) \quad (5)$$

where

L_1 is the energy average sound pressure level in the source room, in decibels;

L_2 is the energy average sound pressure level in the receiving room, in decibels;

A_0 is the reference absorption area, in square metres (for the laboratory, $A_0 = 10$ m^2);

A is the equivalent absorption area in the receiving room, in square metres.

NOTE 1 $D_{n,e}$ is expressed in decibels.

NOTE 2 To achieve a better signal-to-noise ratio, simultaneous measurements can be performed on more than one element. When performing simultaneous measurements, replace Equation (5) by Equation (6).

$$D_{n,e} = L_1 - L_2 + 10 \lg\left(\frac{nA_0}{A}\right) \quad (6)$$

where

$D_{n,e}$ is the element-normalized level difference of an individual element;

n is the number of installed elements.

3.4
small technical element
building element, excluding windows and doors, with an area of less than 1 m^2, which occurs in a certain number of discrete sizes and transmits sound between two adjacent rooms or between one room and the outdoors independently of any adjoining building elements

4 Facilities and equipment

Laboratory test facilities shall comply with the requirements given in ISO 10140-5.

The equipment used to generate the sound field shall meet the requirements given in ISO 10140-5.

Requirements for the equipment used to measure the sound level, and for calibration of that equipment, are given in ISO 10140-5.

5 Test procedure and evaluation

5.1 General procedure

Two horizontally or vertically adjacent rooms are used, one being designated the source room and the other the receiving room. The test element is mounted in an opening in the partition between those rooms (see Clause 6). In the source room, a diffuse sound field is generated by a moving loudspeaker or loudspeakers at two or more fixed positions. The average sound pressure levels are measured in the source and receiving

rooms, normally in the frequency range of 100 Hz to 5 000 Hz (optionally down to 50 Hz). The equivalent sound absorption area in the receiving room is calculated from reverberation time measurements. From the sound pressure level difference between the rooms, the quantities described in Clause 3 can be evaluated by taking into account the equivalent absorption area and, where appropriate, the size or number of test elements. The procedures used to determine the average sound pressure levels corrected for background noise and the reverberation time are specified in ISO 10140-4.

People shall not be present in the source or receiving rooms during measurements to avoid affecting the sound field.

In the case of sound insulation improvement systems, such as acoustical linings, this procedure is repeated for the basic element and that the element with the lining under test.

5.2 Sound field in the source room

Qualification of the loudspeaker system, the number and positions of loudspeakers and the method of operation shall be performed in accordance with ISO 10140-5.

When using a single sound source at two or more positions, these may be in the same room or the measurements may be repeated in the opposite direction by changing source and receiving rooms with one or more source positions in each room. The latter is not possible if the test element has one surface which is significantly more absorbent than the other (see 6.1).

The microphone positions in the source room shall be outside the direct sound field of the source and the radiation characteristics of the sources shall be taken into account when determining microphone positions, as specified in ISO 10140-4.

5.3 Data processing

Calculate the sound reduction index or the element-normalized level difference (as defined in Clause 3) from the measured (and, if necessary, corrected) energy average sound pressure levels in the rooms and the measured reverberation time, as described in ISO 10140-4.

If sound reduction indices or element-normalized level differences are needed in octave bands, these values shall be calculated from the three one-third octave band values in each octave band using Equation (7) or Equation (8):

$$R_{\mathrm{oct}} = -10 \lg \left(\sum_{n=1}^{3} \frac{10^{-R_{1/3\mathrm{oct},n}/10}}{3} \right) \tag{7}$$

$$D_{\mathrm{n,e,oct}} = -10 \lg \left(\sum_{n=1}^{3} \frac{10^{-D_{\mathrm{n,e},1/3\mathrm{oct},n}/10}}{3} \right) \tag{8}$$

Perform all calculations with the appropriate accuracy and present the final results with no higher precision than to the nearest 0,1 dB.

The evaluation of the single-number rating from the results in one-third octave bands shall be done in accordance with ISO 717-1.

5.4 Expression of results

For the statement of the airborne sound insulation of the test element, the measurement results, R or $D_{\mathrm{n,e}}$, shall be given in decibels at all measurement frequencies in one-third octave bands to one decimal place, both in tabular form and in the form of a curve.

Graphs in the test report shall show the value in decibels plotted against frequency on a logarithmic scale; the following dimensions shall be used:

a) 5 mm for a one-third octave band;

b) 20 mm for 10 dB.

The use of a test report form in accordance with Annex B is preferred. Being a short version of the test report, it shall state all information of importance regarding the test element, the test procedure and the test results.

6 Test arrangement

6.1 General

General requirements for the preparation, curing, installation and mounting of the test element is described in this clause. For specific types of elements and products, detailed specifications may be given in related documents; for instance, test codes are covered in ISO 10140-1.

The test element can be of the following different types [a) to e)].

a) The test element can have dimensions that can be fitted in the available full-size test opening (e.g. brick wall, wooden floor). In this case, it shall be in accordance with 6.2 (test element in large test opening).

b) The test element can be of the same kind as in a), but smaller, provided it fulfils the requirement of 6.3.

c) The dimensions of the test element can be fixed and smaller than the test opening (e.g. doors, windows, window panes and panels). In this case, it shall fulfil the requirements of 6.4.

d) The test element can be small in size and its dimensions ill-defined (e.g. transfer air devices and outdoor air intakes). In this case, shall be in accordance with 6.5.

e) The test element of interest can be connected to a base wall/floor element, for example wall lining, floating floor, window frame and sealing. In this case, it shall fulfil the requirements for specific test codes for procedures and evaluation of the data in ISO 10140-1.

Sound transmission can depend on the temperature, relative humidity and static pressure in the test rooms at the time of test and during curing or conditioning of the test element. The conditions shall be reported.

The sound reduction index of heavyweight walls and floors depends on structural coupling to the laboratory structure. In order to describe the effect of the mounting, it is recommended that the total loss factor be measured and the result stated in the test report (see ISO 10140-4:2010, 4.7).

If the test element is installed in an aperture between the source room and the receiving room, the ratio of the aperture depths on either side of the test element shall be approximately 2:1, within 20 % if possible, unless this is inconsistent with the practical use of the test element.

If the test element has one surface which is significantly more absorbent than the other, the surface with the higher absorption shall face the source room and diffusing elements shall be installed in the source room.

If the test element is intended to be openable, install it for the test in such a way that it can be opened and closed in the normal manner, and open and close it before testing (see ISO 10140-1).

6.2 Full-size test opening

The size of the test element is determined by the full-size test opening of the laboratory test facility as defined in ISO 10140-5.

The test element should be installed in a similar manner to the actual construction with careful simulation of typical connections and sealing conditions at the perimeter and at all joints.

The sound reduction index of twin leaf partitions is influenced by the position of the partition in relation to the acoustic break in the test aperture, if present. Care should be taken in choosing whether the two leaves are mounted on the same side or on different sides of the acoustic break (see ISO 10140-1).

The mounting conditions shall be stated in the test report.

6.3 Reduced-size test opening

Where only walls or floors having small surface areas are available, a smaller size is permissible if the wavelength of free flexural (bending) waves at the lowest frequency considered is smaller than half the minimum dimension of the test element. However, the smaller the test element, the more sensitive the results tend to be to edge constraint conditions and to local variations in sound fields. The sound insulation of the test element itself is also dependent on the size.

If appropriate, it is recommended that the specific small-sized test opening described in ISO 10140-5 be used.

6.4 Reduced-size test elements

When the test element has fixed dimensions smaller than the test opening (e.g. with doors, windows, glazing and façade elements), a special partition of sufficiently high sound insulation shall be built into the test opening and the test element shall be placed in that partition.

The niche depths on each side of the test element shall be different and should be in the ratio 2:1. The boundaries of the niche shall be lined with materials having a sound absorption coefficient of less than 0,1 at all measurement frequencies.

The sound transmitted through this partition and any other indirect path should be negligible compared with the sound transmitted through the test element. If this is not the case, the test results shall be corrected (see Annex A).

If appropriate, it is recommended that the specific small-sized test opening described in ISO 10140-5 be used.

NOTE 1 As the sound insulation of windows, doors and small façade elements depends on the dimensions, the sound insulation can differ considerably in practice if a construction has an area other than the one tested in the laboratory. It is unlikely for test elements (especially window panes) whose areas differ by a ratio of up to 2 to show differences in sound insulation greater than 3 dB in the single-number quantity. With an area greater than that which has been tested, a lower sound insulation generally results. Appropriate values can be obtained only by measuring a test element of the size of interest.

NOTE 2 Measurements on square-shaped elements can give lower sound reduction indices than measurements on rectangular ones with the same area.

6.5 Small technical elements

If the test element is much smaller than the available test opening, a partition of sufficiently high sound insulation shall be built in the test opening and the element shall be placed in this partition. The sound transmitted through this partition and any other indirect path shall be

a) negligible compared with the sound transmitted through the test element, or

b) if this condition cannot be filled, the measured values shall be corrected for the influence of flanking transmission (see 7.2).

The flanking transmission shall be determined by measuring the apparent sound insulation of the partition wall inserted in the test opening. This measurement can be carried out before making the opening for the test element or with plates having a high sound insulation on both sides of the opening.

NOTE Difficulties with an unsatisfactorily low margin between the flanking transmission and the transmission via the test element can be avoided by increasing the number of test elements inserted in the partition.

The test element should be installed in a similar manner to the actual construction with careful simulation of typical connections and sealing conditions at the perimeter.

In order to achieve a realistic wall thickness around the element, it may be practical or necessary to increase or decrease the thickness of the partition wall in the area around the element. For specific elements, the requirements for increasing or decreasing this thickness are given in ISO 10140-1.

The sound insulation of small building elements depends on their dimensions; hence, reliable values can only be obtained by testing the actual size.

7 Limits of performance

7.1 Full-size openings

In laboratories complying with ISO 10140-5, ensure that the sound transmitted by indirect paths is negligible compared with the sound transmitted through the test element. In order to verify this, the measured value, R', shall be compared to the appropriate value of R'_{max} for the laboratory facility. The procedure used to determine R'_{max} is given in ISO 10140-5.

If the measured value of R' for a test element at any frequency is less than or equal to ($R'_{\mathrm{max}} - 15$ dB), the indirectly transmitted sound is considered negligible and the result can be referred to as R.

If R' is larger than ($R'_{\mathrm{max}} - 15$ dB), the contribution of flanking transmission in this specific case shall be investigated. The methods mentioned in ISO 10140-5:2010, Annex A, may be used. If feasible, try to increase the suppression of flanking transmission via the test facility.

A statement in the test report is required if R' is larger than ($R'_{\mathrm{max}} - 15$ dB) (see Clause 9 m). No calculated corrections shall be applied.

7.2 Reduced-size openings

If the test element is mounted in a small test opening or a reduced-size opening, a preliminary test shall be carried out to ensure that sound power transmitted through the surrounding partition is small compared with the sound power transmitted through the test element.

The measured sound insulation of building elements is expressed in terms of the sound reduction index, R. It is convenient to express the flanking transmission as an equivalent sound reduction index related to the same surface area denoted by R'_{F} (see Annex A).

If the measured value of the sound reduction index for a test element is less than ($R'_{\mathrm{F}} - 15$ dB), the indirectly transmitted sound may be considered to be negligible. If the measured value is larger than or equal to ($R'_{\mathrm{F}} - 15$ dB), the measured value shall be corrected using the procedure specified in Annex A.

For small technical elements the sound insulation is expressed in terms of the element-normalized level difference. The flanking transmission should be expressed as an equivalent $D_{\mathrm{n,e}}$ denoted by $D_{\mathrm{n,e,F}}$.

If the measured value of the element-normalized level difference for a test element is less than ($D_{\mathrm{n,e,F}} - 10$ dB), the indirectly transmitted sound may be considered to be negligible. If the measured value is larger than or equal to ($D_{\mathrm{n,e,F}} - 10$ dB) the measured value shall be corrected using the procedure specified in Annex A.

NOTE For small technical elements, the limit is chosen as 10 dB instead of 15 dB, since it is practically more difficult to achieve high limits.

8 Precision

The measurement procedure shall give satisfactory repeatability. This shall be determined in accordance with the method given in ISO 140-2 and shall be verified from time to time, particularly when a change is made in the procedure or instrumentation.

NOTE Numerical requirements for repeatability are given in ISO 140-2.

9 Test report

The test report shall include at least the following information:

a) reference to this part of ISO 10140, i.e. ISO 10140-2:2010;

b) name and address of the testing laboratory;

c) manufacturer's name and product identification;

d) name and address of the organization or person who ordered the test (client);

e) dates of test (date of test, date of issue of the test report and, if available and relevant, date of construction or mounting of the test element and date on which test element or test material was selected);

f) size, shape and volume of both reverberant rooms, construction and thickness of the walls;

g) air temperature, relative humidity and static pressure in the measuring rooms, with measurement uncertainty;

h) brief description of details of measurement procedure and equipment;

i) full description of the test element with sectional drawing, mounting and fixing conditions and details of the test opening, including size, thickness, mass per unit area, curing time and conditions of components, together with a statement indicating who mounted the test element (test institute, manufacturer or other);

j) statement as to whether the test element suffered visible damage during the test, for example compaction (if appropriate);

k) sound reduction index or normalized sound level difference of test element as a function of frequency;

l) single-number rating in accordance with ISO 717-1; it shall be clearly stated that the rating has been based on a result obtained by a laboratory measurement;

m) results which are limits of measurement of the laboratory and are obtained by correcting for the influence of flanking transmission; they shall be given as $R' \geqslant x$ dB; this shall be applied if the sound pressure level in any band is not measurable on account of background noise (acoustic or electrical, see ISO 10140-4, 4.3) and if the measured value of the sound reduction index has been affected by flanking transmission; in the latter case, the appropriate value of R'_{max} or $D_{\text{n,e,F}}$ shall be given;

n) total loss factor, η_{total}, if measured (see ISO 10140-4, 4.7), at all frequencies of measurement, both in tabular form and in the form of a curve;

o) additional information required by test codes referring to this part of ISO 10140, i.e. ISO 10140-2:2010.

The recommended test result form for the expression of results is given in Annex B.

Annex A
(normative)

Measurement of sound transmission through the filler wall and any flanking construction for small-sized or reduced-size test openings

A.1 General

The apparent sound reduction index of the filler wall including all flanking elements, calculated using the area of the test opening, should be at least 6 dB higher than the sound reduction index of the test element at any frequency. This is determined by measuring the apparent sound reduction index with substantially reduced transmission through the test element. The value used for the purpose of this test is denoted as R'_F for building elements or $D_{n,e,F}$ for small technical elements. These are determined as stated in this annex.

A.2 Methods for determining the flanking transmission

A recommended way of reducing transmission through the test element in order to measure R'_F is to mount an additional flexible layer with a mass per unit area of 25 kg/m^2 (e.g. gypsum board covered with a 2 mm thick iron sheet), of which the perimeter is completely tight, in that part of the test opening where the test element is mounted, covering only the test object and not parts of the filler wall itself, and to fill the space between this layer and the test element with absorbing material.

For small technical elements, $D_{n,e,F}$ may be measured for the partition wall without the holes for the mounting of the elements, otherwise the openings may be covered in a similar way to that described above.

An alternative method of determining R'_F may be used if the method given above is not applicable, for example when there is a resonance due to the combination of the test element and the additional layer. Use the additional layer described above, but remove the test element and install 1 mm thick sheet lead glued to wood chipboard at the place of the test opening where the test element was mounted and fill the intervening space with absorbing material. The joint between the two layers of the filler wall (if relevant) shall not be covered by this construction.

A.3 Expression of results

Results of sound insulation measurements of elements in a reduced-size or small test opening evaluated in accordance with this part of ISO 10140 are the sound reduction index denoted in this annex as R'_M or the element-normalized level difference denoted in this annex as $D_{n,e,M}$. This sound reduction index refers to the area, S, which is equal to the test opening.

These values shall be compared with the corresponding values of the flanking transmission R'_F or $D_{n,e,F}$ measured with the constructions described above or an equivalent method. If the difference is greater than or equal to 6 dB but smaller than 15 dB for R'_M, or 10 dB for $D_{n,e,M}$, the result of the measurement shall be corrected for the influence of the flanking transmission by calculating R or $D_{n,e}$ as given in Equation (A.1) or Equation (A.2).

$$R = -10 \lg\left(10^{-R'_M/10} - 10^{-R'_F/10}\right) \quad \text{(A.1)}$$

$$D_{n,e} = -10 \lg\left(10^{-D_{n,e,M}/10} - 10^{-D_{n,e,F}/10}\right) \quad \text{(A.2)}$$

where

R is the corrected sound reduction index of the test element, in decibels;

R'_{M} is the sound reduction index measured with the test element in the test opening, in decibels;

R'_{F} is the flanking sound reduction index measured with the special construction in the test opening, in decibels;

$D_{\mathrm{n,e}}$ is the corrected element-normalized level difference of the test element;

$D_{\mathrm{n,e,M}}$ is the element-normalized level difference measured, including flanking transmission through the filler wall;

$D_{\mathrm{n,e,F}}$ is the flanking element-normalized level difference measured without openings or with sealed openings in the filler wall.

If the difference $(R'_{\mathrm{F}} - R'_{\mathrm{M}})$ or $(D_{\mathrm{n,e,F}} - D_{\mathrm{n,e,M}})$ is less than 6 dB in any of the frequency bands, the correction shall be 1,3 dB; this corresponds to a difference of 6 dB. In this situation, R'_{F} or $D_{\mathrm{n,e,F}}$ shall be stated in the test report such that it is clear that the reported values are minimum values.

Table A.1 gives typical values of R'_{F} for a small test opening in a laboratory capable of measuring elements (in an aperture of 1 250 mm × 1 500 mm) having R_{w} values up to 45 dB. The values in Table A.1 are given as an example only and should not be regarded as target values.

Table A.1 — Typical values of R'_{F} in a laboratory with a small test opening of dimensions 1 250 mm × 1 500 mm

f Hz	R'_{F} dB	$R'_{\mathrm{F,w}}$ dB	C dB	C_{tr} dB
100	35	59	–2	–7
125	40			
160	42			
200	47			
250	50			
315	52			
400	54			
500	56			
630	58			
800	60			
1 000	62			
1 250	63			
1 600	65			
2 000	67			
2 500	68			
3 150	70			
4 000	72			
5 000	73			

Annex B
(informative)

Form for the expression of results

Figure B.1 gives an example of the form for the expression of results for the laboratory measurement of airborne sound insulation of building elements. The same type of form should be used for the element-normalized level difference or the improvement of sound reduction index by linings.

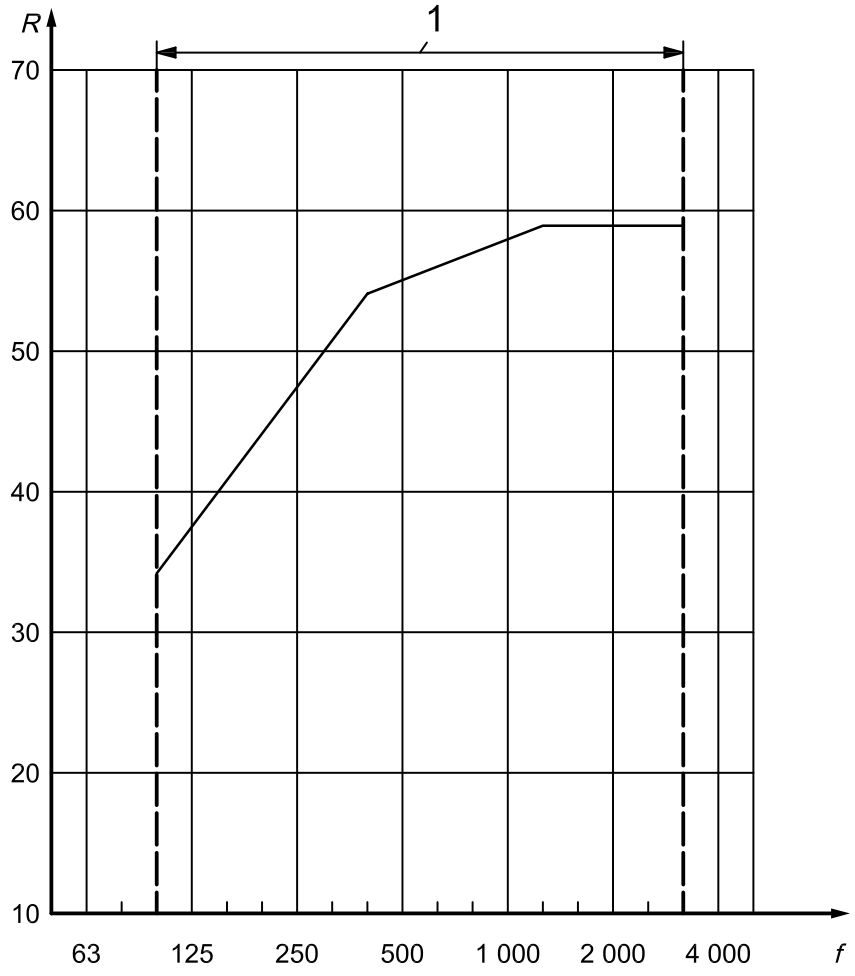
The curve of reference values shown in the form is taken from ISO 717-1. It should be supplemented, or at least replaced, by the shifted reference curve according to the procedure described in ISO 717-1.

Figure B.1 — Example of form for the expression of results

Sound reduction index, R, in accordance with ISO 10140-2

Manufacturer: Product identification:
Client: Test room identification:
Test element mounted by: Date of test:
Description of test facility, test element and test arrangement, including reference to ISO 10140-1, where applicable:
Area, S, of test element: m^2
Mass per unit area: kg/m^2
Air temp. in the test rooms: °C
Relative humidity in the test rooms: %
Static pressure: MPa
Receiving room volume: m^3

Frequency f Hz	R one-third octave dB
50	
63	
80	
100	
125	
160	
200	
250	
315	
400	
500	
630	
800	
1 000	
1 250	
1 600	
2 000	
2 500	
3 150	
4 000	
5 000	



Key
R sound reduction index, in dB
f frequency, in Hz
1 frequency range for rating in accordance with the curve of reference values (ISO 717-1)

Rating in accordance with ISO 717-1:
$R_w(C; C_{tr})$ = ( ) dB $C_{50\text{-}3\,150}$ = dB; $C_{50\text{-}5\,000}$ = dB; $C_{100\text{-}5\,000}$ = dB

Evaluation based on laboratory measurement results obtained by an engineering method:
$C_{tr,50\text{-}3\,150}$ = dB; $C_{tr,50\text{-}5\,000}$ = dB; $C_{tr,100\text{-}5\,000}$ = dB

No. of test report: Name of test institute:
Date: Signature:

Bibliography

[1] ISO 140-4, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 4: Field measurements of airborne sound insulation between rooms*

[2] ISO 140-5, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 5: Field measurements of airborne sound insulation of façade elements and façades*

[3] ISO 140-7, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 7: Field measurements of impact sound insulation of floors*

[4] ISO 140-14, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 14: Guidelines for special situations in the field*

[5] ISO 140-18, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 18: Laboratory measurement of sound generated by rainfall on building elements*

[6] ISO 15186-1, *Acoustics — Measurement of sound insulation in buildings and of building elements using sound intensity — Part 1: Laboratory measurements*

[7] ISO 15186-3, *Acoustics — Measurement of sound insulation in buildings and of building elements using sound intensity — Part 3: Laboratory measurements at low frequencies*

[8] HOPKINS, C. *Sound insulation*. Amsterdam: Elsevier/Butterworth-Heinemann, 2007, 622 pp.

ICS 91.120.20

Price based on 13 pages